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Spaced learning in word analysis

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SPACED LEARNING IN WORD ANALYSIS

Submitted by

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STATEMENT OF PROBLEM AND RESEARCH

CHAPTER 1

This study was undertaken to determine if the skills of word analysis are retained better under the massing of practices (unspaced learning) or under the distribution of practices (spaced learning) on both immediate and delayed recall.

"Distribution of practice generally makes for economy. Under distribution of practice a fact is learned or a skill acquired, with less work than if the practice were massed."1/

Hunter states, "The experimental findings indicate that, within certain limits, learning is accomplished with less work when practice is distributed than when it is concentrated."2/

Boring, Langfeld, Weld, (et al.) say, "The conclusion is well established that, over a wide range of conditions, some form of positive distribution is a more favorable condition of learning than is zero distribution or massed practice."3/

1/ Lorge, I., "Influence of Regularly Interpolated Time Intervals Upon Subsequent Learning", Contributions to Education, #438, Teachers College, Columbia University, 1930.

2/ Hunter, W., "Experimental Studies of Learning", Chap. XV in C.Murchinson, The Foundations of Experimental Psychology. 1929.

3/ Boring, E.,Langfeld, H.,Weld, H.,et al., Psychology, A Factual Textbook, p. 321. 1935.

Dashiell states, "from a great number of such researches (Ebbinghaus, Starch) we may consider it well established that, in learning any kind of habit, economy is found by spacing the practice with time intervals instead of attempting to get it completely formed all at one sitting."1/

"It has been found in general that the spacing or distributing of practice periods over a considerable length of time is more saving in the total time and effort spent in memorizing than in trying to learn all the material at one or a few sittings."2/

However, Boring,(et al.) say that "Relatively short intervals are often more detrimental. Very long ones, particularly those which are longer than a few days, are almost always detrimental."3/

Ebbinghaus in an experimental study which involved the learning of a list of twelve nonsense syllables to the point of one correct reproduction, followed immediately by repetitions, found that twenty-four hours later, only

1/Dashiell,J., Fundamentals of General Psychology, p. 410. 1937.

2/Commins,W., Principles of Educational Psychology, p. 411 1937.

3/Boring,E.,Langfeld,H.,Weld,H.,et al., Psychology, A Factual Textbook, p. 321. 1935.

seven repetitions were required to make one correct reproduction. In another experiment with a different list, the same learner reached approximately the same stage in learning with only thirty-eight repetitions spaced over three days. From these results Ebbinghaus concluded: "With any considerable number of repetitions a suitable distribution of them over a space of time is decidedly more advantageous than the massing of them at a single time."1/

The results of Lyons were of similar import. He learned, among other materials, lists of nonsense syllables by the unspaced (massed) and the one-trial-per-day method to the point of one correct repetition. The time required to learn forty-eight nonsense syllables was fifteen minutes and forty-three minutes, respectively, by spaced practice and unspaced practice; seventy-two syllables required twenty-five minutes and one hundred thirty-eight minutes respectively, by spaced and unspaced practice.2/

Robinson's subjects memorized lists of three-place numbers, each number exposed two seconds. There was no time interval between numbers, but six seconds separated the lists. Ten lists were presented to different groups under

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1/ Ebbinghaus, H., Memory, p.123. 1913.

2/ Lyon, D., "The Relation of Length of Material to Time Taken for Learning, and the Optimum Distribution of Time," Part 11, Journal of Educational Psychology, 5:85-91. 1914.

four conditions of practice: (1) twelve presentations at one sitting; (2) six presentations at each of two sittings, twenty-four hours apart; (3) six presentations at one sitting; (4) three presentations at each of two sittings, twenty-four hours apart. Recall was five minutes, twenty minutes, and twenty-four hours later. With one exception, the distribution of twelve presentations (2) was superior to massing by the criteria of total number of digits recalled, number correct, and average time required for recall per digit. The recall after the three-three presentations (4) was generally inferior to the recall after six massed presentations.1/

Starch analyzed the results from the following periods of code translation: one hundred twenty minutes of continous work; forty minutes every other day for six days; twenty minutes once per day for six days; ten minutes twice per day for six days. The poorest record was made in the one hundred twenty minute period, and the best record in the ten minute period.2/

Murphy found that three practice periods per week were far superior in both immediate gains and retention

1/Robinson, E., "The Relative Efficiency of Distributed and Concentrated Study in Memorizing," Journal of Experimental Psychology, 4:327-343. 1921.

2/Starch, D., "Periods of Work in Learning," Journal of Educational Psychology, 3:209-213. 1912.

to daily practice in javelin throwing. Ten successive throws were better than two periods per day of five throws each. In general, all results seemed to indicate fewer practice periods.1/

In Carr's experimental study one group practiced in a maze one trial per day for ten days, and ten trials on the eleventh day. The second group reversed the procedure. The first group made fewer errors than the second group, but the time difference in learning was insignificant.2/

Lorge used zero, one minute, and one day intervals between one-minute practice periods on the stabilimeter. The one day interval was slightly superior to the one-minute interval, and both were superior to the zero interval.3/

Hovland's subjects learned twelve-unit lists of nonsense syllables under the following conditions of practice:

	Inter-list Interval	Each Syllable Exposed	Av. No. Trials Required
1. Massed	6"	2"	14.89
2. Massed	6"	4"	6.78
3. Distributed	2'-6"	2"	11.18
4. Distributed	2'-6"	4"	5.85

1/ Murphy, H., "Distribution of Practice Periods in Learning," Journal of Educational Psychology, 7:150-162. 1916.

2/ Carr, H., "Distribution of Effort," Psychological Bulletin, 16: 26-28. 1919.

3/ Lorge, I., "Influence of Regularly Interpolated Time Intervals Upon Subsequent Learning," Contributions to Education #438, Teachers College, Columbia University, 1930.

All results indicated that distributed practice, whether by intervals between lists, by longer exposure per item, or by combining the two methods, is superior to massed practice in in regard to the number of trials. The time advantage of (2) and (4) over groups (1) and (3) was insignificant.1/

From his data secured in experiments at college level, Gentry established the following facts: (1) Under massed practice the lowest scores were made. (2) Under distributed practice the highest scores were made. (3) When conditions of of practice were the same for two or more groups, the performance curves were almost identical. (4) When the conditions were changed from massed to distributed practice, the accomplishment increased. (5) When the conditions were changed from distributed to massed practice, the accomplishment decreased.2/

Gordon used meaningful material in her study. Four psychology classes heard and recalled the Athenian Oath under these conditions:

	No. of Readings	Type of Drill	Average Score on Recall Immediate	Delayed
Class 1	6	Unspaced	80	37
Class 2	6	Spaced	76	48
Class 3	3	Unspaced	54	26
Class 4	3	Spaced	45	32

1/Hovland,C., "Experimental Studies in Rote Learning Theory 111. Distribution of Pretice with Varying Speeds of Syllable Presentation,"Journal of Experimental Psychology,23:172-190. 1938.
2/Gentry,J.,"Immediate Effects of Interpolated Rest Periods on Learning Performance,"Contributions to Education #799,Teachers College,Columbia University,1940.

The best immediate recall was made under massed practice, but the best delayed recall was made under distribution of practice.1/

Ruch's summary of the experimental literature on distribution and massing of practice for humans states that "the following factors have received experimental consideration and are of major importance: first, the general characteristics of the distribution of practice (number and length of periods, intervals between periods, degree of learning considered, etc.); second, the type of material being learned; third, the age of the subjects; fourth, criterion or aim of the learning (immediate or delayed recall, speed, accuracy, the amount of recall, improvement, etc.); fifth, the order of repetitions within a practice period (whole versus part order); sixth, the manner of studying; seventh, the stage of learning (whether the distribution is equally effective at the initial and final stages of learning and in exercise of a well learned habit."2/

The following experiment is concerned with the fourth factor. The purposes of the study are;

1. To determine if the skills of word analysis are retained better under spaced or unspaced learn-

1/Gordon, K., "Class Results with Spaced and Unspaced Memorizing," Journal of Educational Psychology, 12:92-97. 1921
2/Ruch, T., "Factors Influencing the Relative Economy of Massed and Distributed Practice in Learning," Psychological Review, 35, 1, 19-45.

practices on immediate recall.

2. To determine if the skills of word analysis are retained better under spaced or unspaced practices on delayed recall.

CHAPTER 11

PLAN AND CONDUCT OF THE EXPERIMENT

CHAPTER 11

This experiment will always be concerned with the achievement after the same kind and number of units of practice of one group--a group that practiced under distribution or spaced learning, and that practiced under massed or unspaced learning.

The specific type of distributed practice used in this study is that form of distribution in which a constant time interval is spaced after each constant unit of practice.

The specific type of massed practice used is that form of massing in which no constant time interval is spaced after each constant unit of practice.

The study was conducted for eight weeks as a class experiment. Thirty pupils of a combined second and third grade in the town of Wellesley, Massachusetts were used as subjects. No attempt was made to differentiate sexes due to the small number of children in the experiment.

From the results of the Kuhlmann Anderson Intelligence Test the following facts were secured:

	C.A.	M.A.	I.Q.
Mean	8.5	8.5	100
Range	6-6 to 11-1	7-6 to 9-9	78 to 125

One hundred phonograms commonly allotted to

first, second, and third grades were chosen for preliminary testing. These phonograms were presented to each child by tachistoscopic flash of one-fifth second duration. From this check the order of difficulty was determined by checking the frequency of correct responses. Pairs of phonograms were equated and selected on this basis for the units of practice under spaced and unspaced learning. All phonograms selected were unknown by 73.33% to 86.67% of the class:

Spaced Learning		Unspaced Learning	
oast-----og	86.67%	age-----aid	86.67%
ile------eak	83.33%	ock-----ead	83.33%
ot-------onk	80%	ue------ick	80%
unk------oss	76.67%	alk-----ig	76.67%
oon------aw	76.67%	ob------igh	76.67%
atch-----oil	76.67%	itch----ore	76.67%
ood------ill	73.33%	oom-----ent	73.33%
ain------uck	73.33%	ape-----ack	73.33%

Five units of practice were used for the purposes of this study.1/ An explanation of their composition and method of administration is necessary:

1. Combining Visual and Auditory Analysis.

The experimenter wrote on the blackboard two words containing the phonograms to be presented--cross, sunk. The children gave other words they thought

1/ Durrell, D., "Word Analysis", Improvement of Basic Reading Abilities, Chap. IX, p. 208-214. 1940.

rhymed with them, such as toss, boss, gossip, drunk, bunk, punk, etc. These words were written on the blackboard as given.To make the group conscious of the similarity in words a child circled the parts in each word which were alike. Sunk was changed to sank and cross to cress to show that a change in one letter changes the sound. The children were then asked to shut their eyes and try to "see" the word sunk. The word was then written on the blackboard and the question asked, "How many saw the word correctly?" This was tried with several words containing the phonograms until most of the group had no difficulty.

2. Completing Words from Phonograms.

Several unks and osses were written on the blackboard in random order and different children were asked to go to the board and complete words they had thought of.

3. Quick-flash Presentation of Words Studied.

Most of the words given and studied in presentations 1 and 2 were printed on cards and quickly flashed for sight recognition. Questions or statements relavant to the word were given; for example:

At camp we sleep in a	bunk
It grows in the woods.	moss
This word means the same as shiny	glossy

What do we call old things we sometimes throw away? junk

4. Identification of Known Words in Paragraphs.

Paragraphs containing the words familiar to the subjects from presentations 1, 2, and 3 were typed, mimeographed, and given to each subject to read. The experimenter heard each child read the paragraph. The words containing the phonograms were identified.

5. Identification of Unknown Words in Paragraphs.

Paragraphs containing the words not specifically taught, but which contained the phonograms presented were typed, mimeographed, and given to each subject to read. The experimenter heard each child read the paragraph and identify the phonogram.

By the spaced or distributed method of learning the units of practice were spaced over eleven days with four, one day intervals and one, three day interval.

By the unspaced or massing method of learning each unit of practice was presented to the subjects in the order explained on five successive days.

The conditions, the units of practice, the hour of presentation, and the time intervals were as shown

in the schedule below:

Date	No.in Class	Condition Spaced	Hour	No.of Unit	Condition Unspaced	Hour	No.of Unit
1/13/41	30	alk,ig	10:45A.M.	(1)	unk, oss	9A.M.	(1)
1/14/41	30	age,aid	10:45A.M.	(1)	unk, oss	9A.M.	(2)
1/15/41	30	alk,ig	10:45A.M.	(2)	unk, oss	9A.M.	(3)
1/16/41	30	age,aid	10:45A.M.	(2)	unk, oss	9A.M.	(4)
1/17/41	30	alk, ig	10:45A.M.	(3)	unk, oss	9A.M.	(5)
1/20/41	30	age,aid	10:45A.M.	(3)	oast,og	9A.M.	(1)
1/21/41	30	alk,ig	10:45A.M.	(4)	oast,og	9A.M.	(2)
1/22/41	30	age, aid	10:45A.M.	(4)	oast,og	9A.M.	(3)
1/23/41	30	alk,ig	10:45A.M.	(5)	oast,og	9A.M.	(4)
1/24/41	30	age,aid	10:45A.M.	(5)	oast,og	9A.M.	(5)
1/27/41	30	ock,ead	9A.M.	(1)	ile,eak	10:45A.M.	(1)
1/28/41	30	oom,ent	9A.M.	(1)	ile,eak	10:45A.M.	(2)
1/29/41	30	ock,ead	9A.M.	(2)	ile,eak	10:45A.M.	(3)
1/30/41	30	oom,ent	9A.M.	(2)	ile,eak	10:45A.M.	(4)
1/31/41	30	ock,ead	9A.M.	(3)	ile,eak	10:45A.M.	(5)
2/3/41	30	oom,ent	9A.M.	(3)	ood,ill	10:45A.M.	(1)
2/4/41	30	ock,ead	9A.M.	(4)	ood,ill	10:45A.M.	(2)
2/5/41	30	oom,ent	9A.M.	(4)	ood,ill	10:45A.M.	(3)
2/6/41	30	ock,ead	9A.M.	(5)	ood,ill	10:45A.M.	(4)
2/7/41	30	oom,ent	9A.M.	(5)	ood,ill	10:45A.M.	(5)
2/10/41	30	ob,igh	10:45A.M.	(1)	oon,aw	9A.M.	(1)
2/11/41	30	ue,ick	10:45A.M.	(1)	oon, aw	9A.M.	(2)
2/12/41	30	ob,igh	10:45A.M.	(2)	oon,aw	9A.M.	(3)
2/13/41	30	ue,ick	10:45A.M.	(2)	oon,aw	9A.M.	(4)
2/14/41	30	ob,igh	10:45A.M.	(3)	oon,aw	9A.M.	(5)
2/17/41	30	ue,ick	10:45A.M.	(3)	ot,onk	9A.M.	(1)
2/18/41	30	ob,igh	10:45A.M.	(4)	ot,onk	9A.M.	(2)
2/19/41	30	ue,ick	10:45A.M.	(4)	ot,onk	9A.M.	(3)
2/20/41	30	ob,igh	10:45A.M.	(5)	ot,onk	9A.M.	(4)
2/21/41	30	ue,ick	10:45A.M.	(5)	ot,onk	9A.M.	(5)
3/3/41	30	itch,ore	9A.M.	(1)	atch,oil	10:45A.M.	(1)
3/4/41	30	ape,ack	9A.M.	(1)	atch,oil	10:45A.M.	(2)
3/5/41	30	itch,ore	9A.M.	(2)	atch,oil	10:45A.M.	(3)
3/6/41	30	ape,ack	9A.M.	(2)	atch,oil	10:45A.M.	(4)
3/7/41	30	itch,ore	9A.M.	(3)	atch,oil	10:45A.M.	(5)

Date	No.in Class	Condition Spaced	Hour	No.of Unit	Condition Unspaced	Hour	No.of Unit
3/10/41	30	ape,ack	9A.M.	(3)	ain,uck	10:45A.M.	(1)
3/11/41	30	itch,ore	9A.M.	(4)	ain, uck	10:45A.M.	(2)
3/12/41	30	ape,ack	9A.M.	(4)	ain,uck	10:45A.M.	(3)
3/13/41	30	itch,ore	9A.M.	(5)	ain,uck	10:45A.M.	(4)
3/14/41	30	ape,ack	9A.M.	(5)	ain,uck	10:45A.M.	(5)

The spaced and unspaced conditions of practice were designed to be as similar as possible in all respects except the time intervals. Motivation did not seem to be an important factor in this study. Utmost effort was taken to eliminate any element of fatigue or tension that might lower accomplishment or interfere with the learning process.

"In testing whether a child has acquired an adequate knowledge of any word element, it is essential to discover whether or not he can use it in solving a word."1/

To determine if the skills of word analysis are retained better by spaced or unspaced learning on immediate recall, six words for each phonogram presented, were tested at the end of the five units of practice. This test consisted of a tachistiscopic flash of one-fifth, one half, and three second's duration. If a word was not given promptly on the three second flash it was counted as an error. The utmost care was exercised in equating the test words in r respect to their unfamiliarity to the subjects.

1/ Durrell, D., "Word Analysis", Improvement of Basic Reading Abilities, Chap. IX, p.198-199.1940.

To determine if the skills of word analysis are retained better by spaced or unspaced learning on delayed recall the same words tested for immediate recall were re-tested after a four week interval. The same procedure was used in checking delayed recall that was used for immediate.

In order to compare the spaced method of learning with the unspaced method of learning for the purposes of this study the mean, the standard error of the mean, the difference between the means, the standard error of the difference, and the ratio were computed for the tests of both immediate and delayed recall.

CHAPTER 111

STATISTICAL ANALYSIS

OF DATA

CHAPTER 111

The following table presents the number of correct responses on the tachistiscopic test for immediate recall under the spaced learning condition.

Table 1

No. of Case	one fifth second	one half second or less	three seconds or less
1.	95	96	96
2.	30	37	57
3.	49	65	81
4.	70	86	95
5.	55	74	86
6.	93	94	95
7.	96	96	96
8.	49	62	78
9.	75	87	94
10.	50	63	79
11.	79	91	95
12.	91	96	96
13.	94	96	96
14.	68	79	93
15.	94	96	96
16.	91	96	96
17.	78	90	91
18.	75	87	94
19.	42	49	67
20.	90	96	96
21.	91	94	95
22.	93	96	96
23.	94	96	96
24.	96	96	96
25.	92	95	96
26.	90	95	96
27.	52	69	81
28.	94	96	96
29.	92	95	96
30.	86	96	96

The following table presents the number of correct responses on the tachistiscopic test for immediate recall under the unspaced learning condition.

Table 11

No. of Case	one fifth second	one half second or less	three seconds or less
1.	92	94	96
2.	21	23	41
3.	41	48	66
4.	71	86	95
5.	49	64	84
6.	90	93	96
7.	93	95	96
8.	31	36	59
9.	77	86	91
10.	29	33	54
11.	71	79	90
12.	91	93	96
13.	90	94	96
14.	63	74	86
15.	91	94	95
16.	88	94	96
17.	74	81	89
18.	62	72	88
19.	29	34	45
20.	84	91	93
21.	72	80	95
22.	90	93	95
23.	90	94	94
24.	94	95	96
25.	77	91	95
26.	90	96	96
27.	53	64	79
28.	93	96	96
29.	85	92	95
30.	79	92	96

Distribution of the Scores of the Thirty Children on the Tachistiscopic Test of One-fifth Second Duration for Immediate Recall under Spaced and Unspaced Learning.

Table 111

Spaced Learning		Unspaced Learning	
Score	Frequency	Score	Frequency
95-100	3	90-94	11
90-94	13	85-89	2
85-89	1	80-84	1
80-84	0	75-79	3
75-79	4	70-74	4
70-74	1	65-69	0
65-69	1	60-64	2
60-64	0	55-59	0
55-59	1	50-54	1
50-54	2	45-49	1
45-49	2	40-44	1
40-44	1	35-39	0
35-39	0	30-34	1
30-34	1	25-29	2
	N. 30	20-24	1
			N. 30
Mean	78.85	Mean	72.5
S.D.	19.1	S.D.	21.05

A further analysis of the distribution of scores found in the graph which follows this.

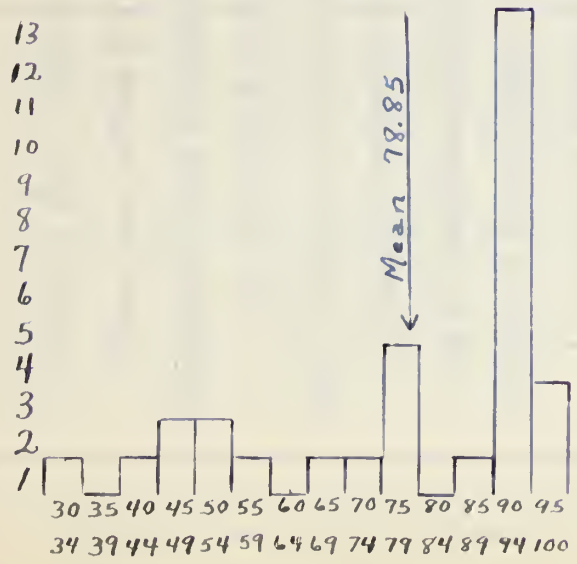
The mean falls at 78.85 for the tachistiscopic test of one-fifth second duration on the spaced learning method. Sigma, or the standard deviation equalled 19.1. The standard deviation was large due to the size and number of extreme variations.

The mean falls at 72.5 for the tachistiscopic test of one-fifth second duration under the unspaced learning

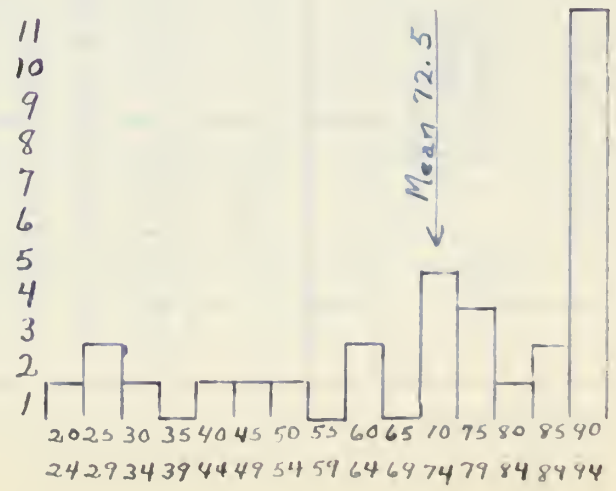
Graph 1.

Distribution of Scores on Tachistiscopic Test of One-fifth Second Duration for Immediate Recall under Spaced and Unspaced Learning.

Spaced Learning



Unspaced Learning



method. Sigma, or the standard deviation equalled 21.05.

Table IV

Type of Practice	Mean	Standard Error of Mean	Difference	Standard Error of Difference	Ratio
Spaced	78.85	3.49	6.35	5.19	1.22
Unspaced	72.5	3.84			

The standard error of the mean on the tachistiscopic test of one-fifth second duration for immediate recall was 3.49 under spaced learning. This indicates that if similar measurements were made of such groups approximately two thirds(68.26%) of all the means so found would be within 3.49 of the observed mean 78.85. In other words, the chances are two to one that the true mean lies within 3.49 units of 78.85, or between 75.36 and 82.34.

The standard error of the mean was 3.48 under unspaced learning. The chances are two to one that the true mean lies within 3.48 units of 72.5, or between 68.66 and 76.34.

The scores for the group under spaced and unspaced learning were as follows: The thirty children averaged 78.85 with a sigma of 19.1 under spaced learning; the same group averaged 72.5 with a sigma of 21.05 under spaced learning. The difference between the two means, 78.85-72.5 was 6.35. To determine its significance the standard error of the difference was computed. The standard error of the difference was found to be 5.19. The chances are two to one (68.26%) that the true

difference will lie within 5.19 units from the observed difference 6.35. In other words, the chances are two to one that similar groups under spaced learning will exceed groups under unspaced learning on this test by an amount between 1.16 and 11.54.

The ratio between the difference and its standard error was computed. This equalled 1.22 and shows that the zero point is 1.22 ε_D units below the observed difference. In other words, we find that the chances are about 7.7 to 1 that the true difference would not be 1.22 ε_D units below the observed difference. We are therefore justified in saying that, in so far as the test is valid and the group representative, we are not certain that the skills of word analysis are retained better on immediate recall under spaced learning.

Distribution of the Scores of the Thirty Children on the Tachistiscopic Test of One-half Second Duration or less for Immediate Recall under Spaced and Unspaced Learning.

Table V

Spaced Learning		Unspaced Learning	
Score	Frequency	Score	Frequency
95-99	15	95-99	4
90-94	4	90-94	12
85-89	3	85-89	2
80-84	0	80-84	2
75-79	1	75-79	1
70-74	1	70-74	2
65-69	2	65-69	0
60-64	2	60-64	2
55-59	0	55-59	0
50-54	0	50-54	0
45-49	1	45-49	1
40-44	0	40-44	0
35-39	1	35-39	1
		30-34	2
		25-29	0
		20-24	1
	N. 30		N. 30
Mean	86.35	Mean	78.35
S.D.	16.35	S.D.	21.55

The mean falls at 86.35 for the tachistiscopic test of one-half second duration or less on immediate recall under the spaced learning method. Sigma, or standard deviation equalled 16.35.

The mean falls at 78.35 on the same test but under the unspaced learning method. Sigma, or standard deviation equalled 21.55.

Table VI

Type of Practice	Mean	Standard Error of Mean	Difference	Standard Error of Difference	Ratio
Spaced	86.35	2.98	8	4.93	1.62
Unspaced	78.35	3.93			

The standard error of the mean on the tachistiscopic test of one-half second duration or less for immediate recall under spaced learning was 2.98. The chances are two to one that the true mean lies within 2.98 units of 86.35, or between 83.37 and 89.33.

The standard error of the mean on the tachistiscopic test of one-half second duration or less for immediate recall under unspaced learning was 3.93. This indicates that the chances are two to one that the true mean lies within 3.93 units of 78.35, or between 74.42 and 82.28.

The difference between the two means, 86.35-78.35 was 8. To determine its significance the standard error of the difference was computed. This equalled 4.93. The chances are two to one(68.26%) that the true mean difference will lie within 4.93 units from the observed difference 8. In other words, the chances are two to one that similar groups under spaced learning will exceed groups under unspaced learning on this test by an amount between 3.07 and and 12.93.

The ratio between the difference and its standard error was 1.62. The chances are about 17.2 to 1 that the true difference would not be 1.62 ε_D units below the observed difference. We are therefore justified in saying that, in so far as the test is valid and the group reprsentative, we are not certain that the skills of word analysis are retained better on immediate recall under spaced learning.

Distribution of the Scores of the Thirty Children on the Tachistiscopic Test of Three Second's Duration or less for Immediate Recall under Spaced and Unspaced Learning.

Table VII

Spaced Learning		Unspaced Learning	
Score	Frequency	Score	Frequency
96-98	15	95-99	16
93-95	7	90-94	4
90-92	1	85-89	3
87-89	0	80-84	1
84-86	1	75-79	1
81-83	2	70-74	0
78-80	2	65-69	1
75-77	0	60-64	0
72-74	0	55-59	1
69-71	0	50-54	1
66-68	1	45-49	1
63-65	0	40-44	1
60-62	0		N. 30
57-59	1		
	N. 30		
Mean	91.71	Mean	86.35
S.D.	9.57	S.D.	16.3

The mean falls at 91.71 for the tachistiscopic test of three second's duration or less on immediate recall under the spaced learning method. Sigma, or the standard deviation equalled 9.57.

The mean falls at 86.35 on the same test but under the unspaced learning method. Sigma, or the standard deviation equalled 16.3.

Table VIII

Type of Practice	Mean	Standard Error of Mean	Difference	Standard Error of Difference	Ratio
Spaced	91.71	1.74	5.36	3.44	1.55
Unspaced	86.35	2.97			

The standard error of the mean on the tachistiscopic test of three second's duration or less for immediate recall under spaced learning was 1.74. The chances are two to one that the true mean lies within 1.74 units of 91.71, or between 89.97 and 93.45.

The standard error of the mean on the tachistiscopic test of three second's duration or less for immediate recall under unspaced learning was 2.97. This indicates that the chances are two to one that the true mean lies within 2.97 units of 86.35, or between 83.38 and 89.32.

The difference between the two means, 91.71-86.35 was 5.36. To determine its significance the standard error of the difference was computed. This equalled 3.44. The chances are two to one that the true mean difference will lie within 3.44 units from the observed difference 5.36. In other words, the chances are two to one that similar groups under spaced learning will exceed groups under unspaced learning on this test by an amount between 1.92 and 8.8.

The ratio between the difference and its standard error was 1.55. The chances are about 15.5 to 1 that the true difference would not be 1.55 ε_D units below the observed difference. We are therefore justified in saying that, in so far as the test is valid and the group representative, we are not certain that the skills of word analysis are retained better under spaced learning.

The following table presents the number of correct responses on the tachistiscopic test for delayed recall under the spaced learning condition.

Table IX

No.of Case	one-fifth second	one-half second or lesss	three seconds or less
1.	95	96	96
2.	34	48	63
3.	65	75	86
4.	73	91	93
5.	78	89	93
6.	94	96	96
7.	96	96	96
8.	67	77	90
9.	84	91	94
10.	65	80	89
11.	87	94	94
12.	94	96	96
13.	94	96	96
14.	63	77	88
15.	96	96	96
16.	94	96	96
17.	82	91	95
18.	83	86	92
19.	35	50	64
20.	90	95	96
21.	88	93	96
22.	94	96	96
23.	92	96	96
24.	95	96	96
25.	92	96	96
26.	94	96	96
27.	63	75	85
28.	95	96	96
29.	94	96	96
30.	88	96	96

The following table presents the number of correct responses on the tachistiscopic test for delayed recall under the unspaced learning method.

Table X

No.of Case	one-fifth second or less	one-half second or less	three seconds or less
1.	88	96	96
2.	17	24	38
3.	33	46	57
4.	54	77	83
5.	62	73	86
6.	92	96	96
7.	91	94	95
8.	55	69	77
9.	83	88	93
10.	42	59	78
11.	67	82	92
12.	85	92	96
13.	88	92	96
14.	55	73	83
15.	93	94	95
16.	90	93	96
17.	66	77	86
18.	71	88	94
19.	18	33	47
20.	83	93	95
21.	82	87	92
22.	87	92	96
23.	86	94	96
24.	92	95	96
25.	84	88	92
26.	92	93	96
27.	56	63	77
28.	92	94	96
29.	86	92	96
30.	85	94	95

Distirbution of the Scores of the Thirty Children on the Tachistiscopic Test of One-fifth Second Duration for Delayed Recall under Spaced and Unspaced Learning.

Table XI

Spaced Learning		Unspaced Learning	
Score	Frequency	Score	Frequency
95-99	5	90-94	7
90-94	10	85-89	7
85-89	3	80-84	4
80-84	3	75-79	0
75-79	1	70-74	1
70-74	1	65-69	2
65-69	3	60-64	1
60-64	2	55-59	3
55-59	0	50-54	1
50-54	0	45-49	0
45-49	0	40-44	1
40-44	0	35-39	0
35-39	1	30-34	1
30-34	1	25-29	0
	N. 30	20-24	0
		15-19	2
			N.30
Mean	82.35	Mean	73.15
S.D.	16.65	S.D.	22

A further analysis of the distribution of scores is found in the graph which follows this.

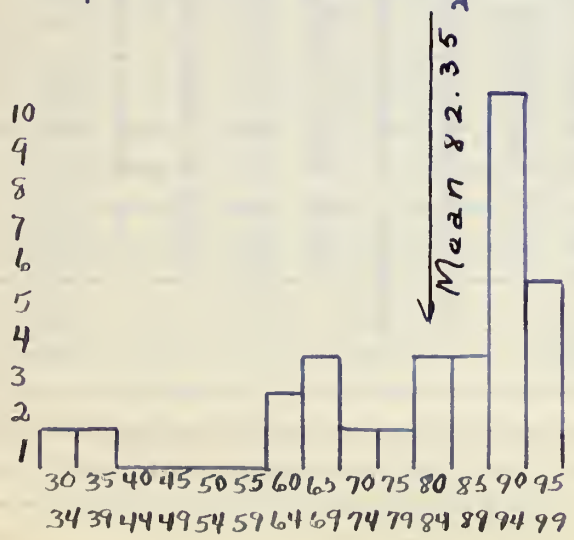
The mean falls at 82.35 for the tachistiscopic test of one-fifth second duration on delayed recall under the spaced learning method. Sigma, or standard deviation equalled 16.65.

The mean falls for the same test but under the unspaced learning method at 73.15. Sigma, or standard deviation equalled 22.

Graph II

Distribution of Scores on Tachistiscopic Test of One-fifth Second Duration for Delayed Recall under Spaced and Unspaced Learning.

Spaced Learning



Unspaced Learning

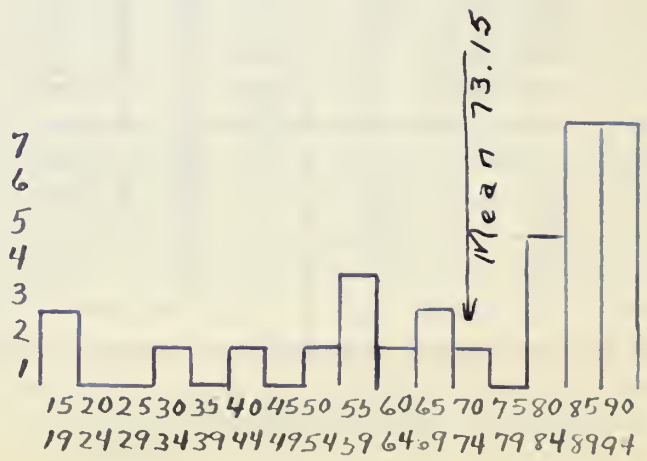


Table XII

Type of Practice	Mean	Standard Error of Mean	Difference	Standard Error of Difference	Ratio
Spaced	82.35	4.01	9.2	5.03	1.83
Unspaced	73.15	3.04			

The standard error of the mean on the tachistiscopic test of one-fifth second duration for delayed recall under spaced learning was 4.01. The chances are two to one that the true mean lies within 4.01 units of 82.35, or between 78.34 and 86.36.

The standard error of the mean for the same test but under the unspaced learning method was 3.04. This indicates that the chances are two to one that the true mean lies within 3.04 units of 73.15, or between 70.11 and 76.19.

The difference between the two means 82.35-73.15 was 9.2. To determine its significance the standard error of the difference was computed. This equalled 5.03. The chances are two to one that the true mean difference will lie within 5.03 units from the observed difference 9.2. In other words, the chances are two to one that similar groups under spaced learning will exceed groups under unspaced learning on this test by an amount between 4.17 and 14.23.

The ratio between the difference and its standard error was 1.83. The chances are about 26.8 to 1 that the true difference would not be 1.83 ε_D units below the

observed difference. We are therefore justified in saying that, in so far as the test is valid and the group representative, we are not certain that the skills of word analysis are retained better under spaced learning.

Distribution of the Scores of the Thirty Children on the Tachistiscopic Test of One-half Second Duration or less for Delayed Recall under Spaced and Unspaced learning.

Table XIII

Spaced Learning		Unspaced Learning	
Score	Frequency	Score	Frequency
95-99	16	95-99	3
90-94	5	90-94	12
85-89	2	85-89	4
80-84	1	80-84	1
75-79	4	75-79	2
70-74	0	70-74	2
65-69	0	65-69	1
60-64	0	60-64	1
55-59	0	55-59	1
50-54	1	50-54	0
45-49	1	45-49	1
	N.30	40-44	0
		35-39	0
		30-34	1
		25-29	0
		20-24	1
			N. 30
Mean	89.65	Mean	80.85
S.D.	12.7	S.D.	18.9

The mean falls at 89.65 for the tachistiscopic test of one-half second duration or less under the spaced learning method. Sigma, or the standard deviation was 12.7

The mean falls at 80.85 for the same test but under the unspaced learning method. Sigma, or the standard deviation equalled 18.9.

Table XIV

Type of Practice	Mean	Standard Error of Mean	Difference	Standard Error of Difference	Ratio
Spaced	89.65	2.32	8.8	4.16	2.22
Unspaced	80.85	3.45			

The standard error of the mean on the tachistiscopic test of one-half second duration or less for delayed recall under the spaced learning method was 2.32. The chances are two to one that the true mean lies within 2.32 units of 86.65, or between 87.33 and 91.97.

The standard error of the mean on the same test but under the unspaced learning method was 3.45. The chances are two to one that the true mean lies within 3.45 units of 80.85, or between 77.40 and 84.30.

The difference between the two means 89.65-80.85 was 8.8. To determine its significance the standard error was computed. This equalled 4.16. The chnaces are two to one that the true difference will lie within 4.16 units from the observed difference 8.8. In other words, the chances are two to one that similar groups under spaced learning will exceed similar groups under unspaced learning by an amount between 4.64 and 12.96.

The ratio between the difference and its standard error was 2.22. The chances are about 70.9 to 1 that the true difference would not be 2.22 ε_D units below the

observed difference. We are therefore justified in saying that, in so far as the test is valid and the group representative, we are not certain that the skills of word analysis are retained better under spaced learning.

Distribution of the Scores of the Thirty Children on the Tachistiscopic Test of Three Second's Duration or less for Delayed Recall under Spaced and Unspaced Learning.

Table XV

Spaced Learning		Unspaced Learning	
Score	Frequency	Score	Frequency
96-98	17	95-99	15
93-95	5	90-94	5
90-92	2	85-89	2
87-89	2	80-84	2
84-86	2	75-79	3
81-83	0	70-74	0
78-80	0	65-69	0
75-77	0	60-64	0
72-74	0	55-59	1
69-71	0	50-54	0
66-68	0	45-49	1
63-65	2	40-44	0
	N.30	35-39	1
			N. 30
Mean	93	Mean	88
S.D.	1.98	S.D.	15.25

The mean falls at 93 for the tachistiscopic test of three second's duration or less on the delayed recall under the spaced learning method. Sigma, or the standard deviation equalled 16.65.

The mean falls for the same test but under the unspaced learning method at 88. Sigma, or standard deviation equalled 15.25.

Distribution of the scores of the Ninety Children on the Tachistoscopic Test of Three Second's Duration or less for Delayed Recall under Guided and Unguided Learning.

Table IV

Guided Learning		Unguided Learning	
Scores	Frequency	Scores	Frequency
0-5	17	0-4	7
6-10	4	5-9	5
11-15	3	10-14	3
16-20	3	15-19	3
21-25	3	20-24	3
26-30	3	25-29	3
31-35	0	30-34	0
36-40	0	35-39	0
41-45	0	40-44	0
46-50	0	45-49	1
51-55	0	50-54	1
56-60	0	55-59	1
61-65	1	60-64	1
	30		30
M. D.	1.96	M. D.	10.25

The mean Delta or D for the Guided Learning was 1.96 showing a superior or less adequate result than the Unguided Learning method. Sigma, or the standard deviation equalled 10.25.

The mean Delta for the Group taught by the Guided Learning method was 1.96. Sigma, or standard deviation equalled 10.25.

Table XVI

Type of Practice	Mean	Standard Error of Mean	Difference	Standard Error of Difference	Ratio
Spaced	93	.36	5.	2.8	1.79
Unspaced	88	2.78			

The standard error of the mean on the tachistiscopic test of three second's duration or less for delayed recall under spaced learning was .36. The chances are two to one that the true mean lies within .36 units of 93, or between 92.64 and 93.36.

The standard error of the mean for the same test but under unspaced learning was 2.78. The chances are two to one that the true mean lies within 2.78 units of 88, or between 85.22 and 90.78.

The difference between the two means 93-88 was 5. To determine its significance the standard error of the difference was computed. This equalled 2.8. The chances are two to one that the true mean difference will lie within 2.8 units from the observed difference 5. In other words, the chances are two to one that similar groups under spaced learning will exceed similar groups under unspaced learning on this test by an amount between 2.2 and 7.8.

The ratio between the difference and its standard error was 1.79. The chances are about 24 to 1 that

the true difference would not be 1.79 ε_D units below the observed difference. We are therefore justified in saying that, in so far as the test is valid and the group representative, we are not certain that the skills of word analysis are retained better under spaced learning.

CHAPTER IV

SUMMARY AND CONCLUSIONS

CHAPTER IV

To determine if the skills of word analysis are retained better by spaced or unspaced learning on immediate recall, six words for each phonogram presented, were selected and tested at the end of the five units of practice by a tachistiscopic flash of one-fifth, one-half and three second's duration. The same words tested for immediate recall were retested after a four week interval for retention on delayed recall.

Conclusions

1. The difference 6.35 between the mean scores of the unspaced and spaced learning on the tachistiscopic test of one-fifth second for immediate recall was insignificant statistically. The difference 8. between the mean scores of the unspaced and spaced learning on the test of one-half second duration for immediate recall fell short of statistical signifiwance. The difference 5.36 between the mean scores of the unspaced and spaced learning on the test of three second's duration for immediate recall was statistically insignificant.
2. The difference 9.2 between the mean scores of the unspaced and spaced learning on the tachistiscopic test of one half second for delayed recall was statistically insignificant. The difference 8.8 between the mean scores

of the unspaced and spaced learning was found to be statistically insignificant on the tachistiscopic test of one-half second duration for delayed recall. The difference 5. between the mean scores of the unspaced and spaced learning on the tachistiscopic test of three second's duration fell short of statistical significance.

3. It would appear from this study that statistically skills of word analysis are not retained better by spaced than by unspaced learning on either immediate or delayed recall. However, in spite of no statistical significance being found, the progression of gain shown in the experiment points to significance in itself. More research is needed.

Implications for Classroom Practice.

The achievement under distribution of practice was generally superior to achievement under the massing of practice in this study.

This appears to suggest that the enviromental factor, the rest period, may be utilized so that achievement is increased. The teacher in the classroom may determine the achievement of pupil practice when motivation is held constant by utilizing the rest period. Higher achievement resulting from distributed practice maintains morale and interest on a higher level. High morale, or self motivation, is the greatest force in any learning situation in the classroom. Not only are interests developed from a high morale but effective study habits may be more easily formed and made permanent.

APPENDIX

The following table presents the results of the Kuhlmann Anderson Intelligence Test:

Case	C.A.	M.A.	I.Q.
1.	7-3	8-1	111
2.	10-3	8	78
3.	10-3	8-6	83
4.	7-10	7-6	96
5.	9-1	8-4	92
6.	7-3	8	110
7.	7-9	8-5	109
8.	10-5	8-7	82
9.	7-8	8-1	105
10.	8-8	8-1	93
11.	7-6	7-7	101
12.	6-6	8	123
13.	7-9	9-8	125
14.	7-8	8	104
15.	7-9	8-4	108
16.	7-8	8-4	109
17.	10-8	8-10	83
18.	8	8-5	105
19.	8-9	8-6	97
20.	8-4	10-2	122
21.	7-7	7-11	104
22.	7-10	8-3	105
23.	7-3	8-1	111
24.	10-7	8-4	79
25.	8-8	8-10	102
26.	8-8	8-7	99
27.	8-2	8-4	102
28.	11-1	9-9	88
29.	8-7	9-3	108
30.	10-2	8-6	84

The following table presents the phonograms of the preliminary test in order of their difficulty as determined by checking the frequency of correct responses to each phonogram among the thirty children.

ome	4	86.67%
og	4	86.67%
age	4	86.67%
oach	4	86.67%
oast	4	86.67%
aid	4	86.67%
om	4	86.67%
ait	5	83.33%
ame	5	83.33%
ock	5	83.33%
ead	5	83.33%
eak	5	83.33%
ile	5	83.33%
ure	5	83.33%
ot	6	80%
ue	6	80%
onk	6	80%
ick	6	80%
oot	6	80%
atch	7	76.67%
oil	7	76.67%
aw	7	76.67%
igh	7	76.67%
tion	7	76.67%
itch	7	76.67%
ob	7	76.67%
alk	7	76.67%
oar	7	76.67%
ig	7	76.67%
arm	7	76.67%
oon	7	76.67%
arn	7	76.67%
orse	7	76.67%
ore	7	76.67%
unk	7	76.67%
oss	7	76.67%
ain	8	73.33%
eech	8	73.33%
ape	8	73.33%
ack	8	73.33%
oom	8	73.33%
ill	8	73.33%
uch	8	73.33%
ood	8	73.33%
ease	8	73.33%
ent	8	73.33%
uck	8	73.33%
ur	9	70%
eap	9	70%
ow	9	70%
ut	9	70%
op	10	66.67%
eep	10	66.67%
ool	10	66.67%
ell	10	66.67%
ank	10	66.67%
ousel	10	66.67%
or	10	66.67%
ilk	10	66.67%
ink	10	66.67%
een	10	66.67%
orn	10	66.67%
ix	10	66.67%
ope	11	66.67%
ote	11	66.67%
ean	11	66.67%
ound	11	66.67%
ass	12	60%
ite	13	56.57%
ake	13	56.57%
ook	13	56.67%
un	13	56.67%
ike	13	56.67%
id	13	56.67%
our	13	56.67%
ine	13	56.67%
eet	13	56.67%
ap	14	53.33%
air	14	53.33%
ight	14	53.33%
ern	14	53.33%
oat	17	43.33%
owe	17	43.33%
own	17	43.33%
end	17	43.33%
ay	18	40%
up	18	40%
all	18	40%
eat	20	33.33%
out	20	33.33%
at	24	20%
oy	24	20%
er	28	6.67%
as	28	6.67%
and	28	6.67%
in	28	6.67%
old	28	6.67%
am	29	3.33%
ing	29	3.33%
it	29	3.33%

The following table presents the test words used for immediate and delayed recall under the spaced and unspaced learning.

Spaced Learning		Unspaced Learning	
coast	hog	age	maid
toast	fog	rage	paid
boast	soggy	page	raid
roast	foggy	caged	maiden
roaster	frogs	stage	laid
coasting	bog	bandage	afraid
pile	weak	dock	steady
filed	speak	flock	instead
smile	streak	frock	ready
tiles	leak	stocking	thread
while	sneak	block	spread
stile	creak	pocket	dread
woods	spill	broom	center
stood	pillow	bloom	roomy
hood	still	lent	spent
good	silly	boom	sent
wooden	ill	doom	enter
woody	killing	gloomy	bent
sooner	straw	hobby	nigh
coon	gnaw	sob	sigh
loon	law	robber	fight
balloons	jaw	mob	slight
spoon	crawl	job	bright
moons	cawed	knob	fright
skunk	crossed	stalk	jig
flunk	loss	chalk	twigs
bunker	tossing	balky	wiggle
shrunk	bossy	walker	trigger
spunk	across	talked	digging
punk	moss	chalky	figs
donkeys	bottom	ticket	true
honking	blotter	nickel	slue
conked	rotted	sticky	cue
honks	shot	stricken	dues
conk	slot	pickles	glue
donkey	cotton	bricks	hue

thatch	spoil	hitching	forehead
broiler	patches	switches	pore
toiler	snatching	pitcher	shore
boiling	latched	ditch	bore
soiled	scratch	stitched	snored
foil	matched	kitchens	swore
sprain	plucky	shaped	tackle
grain	tucked	grapes	crackers
fainted	buckle	caper	tracked
remain	bucket	scrape	sack
stains	stuck	escape	rack
brains	chuck	tape	stack

Unit of Practice--No. IV

Spaced Learning

Billy Ross tossed the ball. What a hit! Away it sailed across the field. Bobby ran like the wind to win the game for his side. Billy was cross because it was a loss for his team. Which side would you have joined if you had been there?

Jerry had a lot of fun camping in the woods. Every night he slept in a bunk. Every day he fed hunks of cheese and bread to the chipmunks and squirrels. One day he stepped on a skunk. Whew! He ran so fast his voice sunk to a whisper. Do you think his mother knew what had happened to him?

Unit of Practice NO.V

Spaced Learning

One day I got lost in the woods. It grew very dark but I was full of spunk. I found some punk with which to start a fire. I had flunked my lesson in fire-making but this time it really started. The skunks and chipmunks watched me. I got some leaves for a bunk and went to sleep. I knew my father would find me. He did,too.

The children went across the crossing into the woods. They started looking for moss. Bobby was the boss and told them how to dig it. Two of the boys did nothing but gossip and they didn't find any. All the rest worked instead of talking. Mother was pleased with them and she liked the moss.

Unit of Practice--No. IV

Unspaced Learning

There was a lesson in Jerry's book about corn. He talked and talked about it. He showed me a picture of the tall stalks. He liked it so much he made one like it with chalk. He even made me in the picture, too. I was walking in the corn. Did you ever walk in a corn field?

I saw a circus parade yesterday. The biggest clown had on a green wig. Every time he danced a jig, the wig fell off! He tried digging in the sand but a pig ran right into him and made the trigger of his gun go off! Bang! Bang! Everyone laughed. I did, too.

Unit of Practice--No. V

Unspaced Learning

My brother Bob has a balky pony. Sometimes the pony won't move at all. Bob is a great talker and he talks to the pony. Sometimes he hits the pony with long stalks of grass. He won't move even then. He runs and gets some carrots he made with orange chalk. What do you suppose the pony does?

Did you ever see a fig tree? The figs I saw grew on twigs high in the air. I climbed that tree because I wanted some figs to eat. I wanted a sprig of leaves to bring home, too. When I started to eat one fig, a little worm wriggled out of it . I was afraid but my brother just giggled at me.

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